CLAIMS

What is claimed is:

1. A method of generating a subscriber line ringing signal for a subscriber line having first and second lines, comprising:

a) applying a time-varying supply level $W(t) = |f(t) - C| + C + D$ to the first line while applying an alternate source $V_{ALT}(t) = D$ to the second line when $f(t) - C > 0$, wherein D is a supply level DC offset, wherein C is a folding line about which $f(t)$ is folded, wherein $C \neq 0$; and

b) applying the time-varying supply level to the second line while applying the alternate source to the second line when $f(t) - C \leq 0$, wherein a resulting ringing signal component of the first line is L1(t), wherein a resulting ringing signal component of the second line is L2(t), wherein the first and second lines form a differential ringing signal line pair providing the differential ringing signal $\Delta L(t) = L1(t) - L2(t) = f(t)$.

2. The method of claim 1 wherein D=0.

3. The method of claim 1 wherein $f(t)$ is periodic with period T, wherein $\frac{1}{T}\int_0^T \Delta L(t) = \overline{L(t)} \neq 0$.

4. The method of claim 1 wherein $W(t) = L1(t) + L2(t)$.

5. The method of claim 1 wherein steps a) and b) are initiated near critical points of $W(t)$ when $W(t) - K = 0$, wherein K is a pre-determined switching threshold, wherein step a) is initiated near a first critical point $W(t_1)$ at $W(t_1 + \varepsilon_1)$, wherein step b) is initiated near a subsequent second critical point $W(t_2)$ at $W(t_2 + \varepsilon_2)$, wherein $|\varepsilon_1|, |\varepsilon_2| << \Delta t = |t_1 - t_2|$.

6. An apparatus for generating a subscriber line ringing signal, comprising:

a power supply providing a time-varying supply level $W(t) = |f(t) - C| + C + D$, wherein D is a power supply offset, wherein $C \neq 0$;

a linefeed driver; and

a signal processor, wherein when $W(t) \leq K$ the signal processor controls the linefeed driver to toggle between 1) coupling $W(t)$ to a tip line while coupling a ring line to an alternate supply, $V_{ALT}(t)$, and 2) coupling $W(t)$ to the ring line while coupling the tip line to $V_{ALT}(t)$, wherein K is a pre-determined switching threshold.

7. The apparatus of claim 6 wherein $D = 0$.

8. The apparatus of claim 6 wherein $f(t)$ is periodic with period T, wherein $\frac{1}{T}\int_0^T \Delta L(t) = \overline{L(t)} \neq 0$.

9. The apparatus of claim 6 wherein K is selected such that the toggling occurs near critical points of $W(t)$, wherein a first toggling occurs at $W(t_1 + \varepsilon_1)$, wherein a second toggling occurs at $W(t_2 + \varepsilon_2)$, wherein $W(t_1)$ and $W(t_2)$ are critical points of $W(t)$, wherein $|\varepsilon_1|, |\varepsilon_2| << \Delta t = |t_1 - t_2|$.

10. A method of generating a differential ringing signal with a DC component between a tip and a ring line of a subscriber line, comprising:

a) providing a time-varying supply level, $W(t)$, having a plurality of critical points along a folding line, wherein the critical points are substantially not equidistant;

b) coupling $W(t)$ to the tip line while coupling an alternate source to the ring line in response to a first critical point; and

c) coupling $W(t)$ to the ring line while coupling the alternate source to the tip line in response to a second critical point.

11. The method of claim 10 wherein the differential ringing signal has a period T, wherein a duration between the first and second critical points is T1, wherein a duration between the second and a next critical point is T2, wherein $T \geq T1 + T2$.

12. The method of claim 10 wherein $T1 \neq T2$, wherein a period of $W(t)$ is $T = T1 + T2$.

13. The method of claim 10 wherein the differential ringing signal is one of a sinusoidal, a trapezoidal, a sawtooth, and a triangular waveform.

14. An apparatus for generating a subscriber line differential ringing signal having a DC component between a tip line and a ring line, comprising:

switch circuitry coupling the tip line to a time-varying power supply $W(t)$ having a plurality of non-equidistantly spaced critical points while coupling the ring line to an alternate source when in a first state, wherein the switch circuitry couples the tip line to the alternate source while coupling the ring line to $W(t)$ when in a second state; and

a signal processor toggling the switch circuitry between the first and second states in response to the critical points.

15. The apparatus of claim 14 wherein the switch circuitry is toggled to the first state in response to a first critical point, wherein the switch circuitry is toggled to the second state in response to a second critical point.

16. The apparatus of claim 15, wherein a duration between the first and second critical points is T1, wherein a duration between the second critical point and a next critical point is T2, wherein the differential ringing signal has a period $T \geq T1 + T2$.

17. The apparatus of claim 16, wherein the differential ringing signal has a period $T = T1 + T2$.

18. The apparatus of claim 14 wherein $W(t)$ resembles one of a full-wave rectified sinusoidal and a full-wave rectified trapezoidal waveform.

19. A method of generating a differential ringing signal, comprising:

a) applying a ringing signal component $L1(t)$ to the tip line; and

b) applying a ringing signal component $L2(t)$ to the ring line,

wherein $L2(t) \neq L1(t + T/2)$, wherein $L1(t)$ and $L2(t)$ have a period of T, wherein at least one of $L1(t)$ and $L2(t)$ varies over the interval $t \in (0, T/2)$, wherein the differential ringing signal $\Delta L(t) = L1(t) - L2(t)$.

20. The method of claim 19 wherein step a) further comprises:

i) applying a time-varying supply level $W(t)$ to the tip line for a duration T1; and

ii) applying an alternate supply level to the tip line for a duration T2, wherein $T1 \neq T2$.

21. The method of claim 20 wherein step b) further comprises:

i) applying the alternate supply level to the ring line while applying $W(t)$ to the tip line for the duration T1; and

ii) applying $W(t)$ to the ring line while applying the alternate supply level to the tip line for the duration T2.

22. The method of claim 20 wherein step i) is initiated when $W(t)$ is near a first critical point, wherein step ii) is initiated when $W(t)$ is near a subsequent second critical point.

23. An apparatus for generating a subscriber line ringing signal, comprising:

a power supply providing a time-varying supply level $W(t)$ having a plurality of non-equidistantly spaced critical points along a same folding line;

a linefeed driver; and

a signal processor controlling the linefeed driver to couple $W(t)$ to a tip line while maintaining a ring line at a pre-determined supply level when in

a first state, wherein the signal processor controls the linefeed driver to couple $W(t)$ to the ring line while maintaining the ring line at the pre-determined supply level in a second state, wherein a resulting ringing signal component of the tip line is $L1(t)$, wherein a resulting ringing signal component of the ring line is $L2(t)$, wherein a differential ringing signal $\Delta L(t) = L1(t) - L2(t)$ has a period T.

24. The apparatus of claim 23 wherein the differential ringing signal is one of a sinusoidal, a trapezoidal, a sawtooth, and a triangular waveform.

25. The apparatus of claim 23 wherein the signal processor toggles the linefeed driver between the first and second states in response to the critical points.

26. The apparatus of claim 23 wherein the coupling of $W(t)$ to a selected one of the tip and ring lines is initiated when $|W(t)| \leq K$, wherein $|W(t)|$ is an absolute value of $W(t)$, wherein K is a pre-determined switching threshold.

27. The apparatus of claim 23 wherein the pre-determined supply level is ground.

28. The apparatus of claim 23 wherein $L1(t)$ and $L2(t)$ resemble one of a half-wave rectified sinusoidal and a half-wave rectified trapezoidal waveforms.

29. The apparatus of claim 23 wherein $W(t)$ resembles one of a full-wave rectified sinusoid and a full-wave rectified trapezoid.